Description

INFORMATION STORAGE MEDIUM HAVING DIFFERENT READ POWER INFORMATION

Technical Field

[1] The present invention relates to an information storage medium having different read power information, and more particularly, to a hybrid information storage medium including a plurality of types of data areas requiring different read powers, respectively, on which different read power information for the respective types of data areas is recorded.

Background Art

[2] Optical information storage media such as optical disks are widely used as information storage media of optical pickups that records/reproduces information in a contact-free way. Such optical disks are divided into compact disks (CDs) and digital versatile disks (DVDs) according to their recording capacities. In addition, high-density optical disks (generally, HD-DVDs) having a recording capacity of 20 GB or more have been developed. As described above, when the capacity of an optical information storage medium increases, a length and a width of a pit formed on a read-only information storage medium are decreased. In this situation, since a signal of a minimum mark becomes very small, general reproduction characteristics deteriorate.

[3] To overcome this problem, a super-resolution optical disk has been proposed. The super-resolution optical disk is an optical recording medium using a super-resolution effect in which recording marks smaller than a resolution of a laser beam are reproduced. Since recording marks having a size beyond a resolution limit can also be reproduced, the super-resolution optical disk remarkably satisfies demands on high density and high capacity.

[4] Like other optical recording media, there are two types of super-resolution optical disk: a read-only disk and a writable disk. In addition, a super-resolution optical disk includes a hybrid disk including both of a read-only area and a writable area. When a hybrid super-resolution optical disk is used, for example, when a hybrid super-resolution optical disk having a game program recorded in its read-only area is distributed and thereafter, the game program is upgraded, a user can download the upgraded game program from a distributor's web site to a writable area on the hybrid super-resolution optical disk. FIGS. 1B and 1C illustrate examples of an internal layer structure of such hybrid super-resolution optical disk. The hybrid super-resolution optical disk may have a 5-layer structure, as shown in FIG. 1B, or a 7-layer structure, as shown in FIG. 1C. Here, the hybrid super-resolution optical disk may have the same

layer structure in its entire area or different layer structures between a read-only area and a writable area. Referring to FIG. 1A, the read-only area may be placed in an outer region 10 of a disk and the writable area may be placed in an inner region 20 of the disk. Conversely, the writable area may be placed in the outer region 10 of the disk and the read-only area may be placed in the inner region 20 of the disk.

[5] Meanwhile, a super-resolution optical disk allowing marks smaller than a readout resolution to be reproduced uses a much greater read power than normal optical disks and greatly different reproduction characteristics depending upon read power. Accordingly, to reliably reproduce data from the super-resolution optical disk, use of an optimal read power is needed. On a conventional super-resolution optical disk, a read power dependency of a read-only area is different from that of a writable area. On a conventional normal optical disk, a writable area and a read-only area have the same read power dependency, and thus the same read power is used throughout a hybrid disk including both of the read-only area and the writable area during reproduction. A conventional hybrid super-resolution optical disk may have areas, for example, a read-only area and a writable area or a super-resolution disk area and a normal disk area, having different read power dependencies. Accordingly, to reliably reproduce data from such conventional hybrid super-resolution optical disk, it is necessary to control a read power of a disk driver for realizing optimal reproduction characteristics and to provide optimal read power information for each area to the disk drive. To satisfy these necessities, recording optimal read power information for each area in a particular portion on an information storage medium is desired.

Disclosure of Invention

Technical Problem

[6] The present invention provides a method for reliably reproducing data from a super-resolution optical disk including a plurality of types of data areas requiring different optimal read powers by providing optimal read power information to an optical disk drive.

[7] The present invention also provides an information storage medium on which optimal read power information is recorded in at least one of a lead-in area and a lead-out area.

[8] The present invention also provides a

[9] super-resolution optical disk drive controlling a read power according to read power information recorded on the information storage medium.

Technical Solution

[10] According to an aspect of the present invention, there is provided a hybrid information storage medium comprises a lead-in area storing basic information regarding

the information storage medium, a lead-out area indicating an end of the information storage medium, a plurality of types of data areas requiring different optimal read powers, and different optimal read power information for the plurality of types of data areas.

[11] The different optimal read power information may be recorded in at least one of the lead-in area and the lead-out area. The different optimal read power information may be recorded in arbitrary fields within a control data zone in the lead-in area.

[12] According to another aspect of the present invention, there is provided a method of recording/reproducing data on/from a hybrid information storage medium including a plurality of types of data areas requiring different optimal read powers according to different optimal read power information recorded on the hybrid information storage medium. The method includes recording the different optimal read power information for the plurality of types of data areas on the hybrid information storage medium, reading the different optimal read power information for each data area from the hybrid information storage medium, and reproducing data from the data area with an optimal read power corresponding to the data area.

[13] The different optimal read power information may be recorded in at least one of a lead-in area and a lead-out area on the hybrid information storage medium.

[14] The reproducing of data may include determining a type of the data area from which the data is reproduced, and controlling an output of a laser diode according to an optimal read power corresponding to a result of the determination.

Advantageous Effects

[15] According to the present invention, since optimal read power information for each area is provided to an optical disc drive when the optical disc drive reproduces data from a hybrid super-resolution optical disk including a plurality of types of data areas requiring different optimal read powers, optimal reproduction characteristics can always be obtained reliably.

Description of Drawings

[16] FIGS. 1A through 1C illustrate a hybrid super-resolution optical disk used in the present invention and examples of its internal layer structure;

[17] FIG. 2 is a graph illustrating comparison of characteristics with respect to a read power between a read-only area and a writable area on a hybrid super-resolution optical disk;

[18] FIG. 3 illustrates a structure of a normal data area of a disk;

[19] FIG. 4 illustrates a data structure in a lead-in area;

[20] FIG. 5 illustrates a method of recording read power information according to an embodiment of the present invention; and

[21] FIG. 6 is a schematic diagram of a recording/reproducing system for an information storage medium according to an embodiment of the present invention.

Mode for Invention

[22]

[23] Hereinafter, the present invention will be described in detail by explaining preferred embodiments of the invention with reference to the attached drawings.

[24] As described above, since a super-resolution optical disk greatly depends on a read power more than a normal optical disk, use of an optimal read power is required to reliably reproduce data from the super-resolution optical disk. Accordingly, when data is reproduced from a hybrid super-resolution optical disk using a fixed single read power, the data may not be normally reproduced. Conventional normal hybrid phase-change optical disks have a low dependency on a read power. Accordingly, even if a single fixed read power is used throughout the disk, data can be reliably reproduced. However, for a hybrid super-resolution optical disk including a read-only area and a writable area which require different optimal read powers, it is needed to use the different optimal read powers when data is reproduced from the read-only area and when data is reproduced from the writable area, respectively, to reliably reproduce the data.

[25] FIG. 2 is a graph illustrating comparison of characteristics with respect to a read power between a read-only area and a writable area on a hybrid super-resolution optical disk. Here, the hybrid super-resolution optical disk has a 5-layer structure. As shown in FIG. 2, in the writable area (i.e., a write-once-read-many (WORM) type) having a 100-nm recording mark, a maximum signal-to-noise ratio (SNR) of 40 dB was measured at a read power of about 1.8 mW. In the read-only area (i.e., a read-only memory (ROM) type) having the same 100-nm recording mark, a maximum SNR of 37 dB was measured at a read power of about 2.4 mW. Consequently, the hybrid super-resolution optical disk with the 5-layer structure had a difference of about 0.6 mW in an optimal read power. This result implies that different read powers are needed when a super-resolution disk drive reads data from the read-only area and the writable area, respectively, to reliably reproduce the data. Accordingly, optimal read power information for each area on the hybrid super-resolution optical disk needs to be provided to the disk drive.

[26] The present invention enables read power information to be recorded in a particular portion of a hybrid super-resolution optical disk and enables a disk drive to read the read power information from the disk in advance to reproduction of data. For this operation, an appropriate portion in which read power information for each area is recorded needs to be defined.

[27] FIG. 3 illustrates a conventional structure of a data area on an optical disk. In

detail, a through-hole 41 is formed at a center of an optical disk such that the optical disk is put around a central shaft of a turntable within a disk drive through the through-hole 41. A clamping area 42 for holding the optical disk is formed concentrically with the through-hole 41 to have a predetermined distance from the through-hole 41. No data is stored in the clamping area 42. Next, a lead-in area 43 storing information regarding the optical disk, such as a start position of data and a name of the optical disk, and information regarding data recorded on the optical disk is formed. Next to the lead-in area 43, a recording area 44 storing user data is formed. In case of a hybrid super-resolution optical disk, a read-only area and a writable area are present in the recording area 44. Next, a lead-out area 45 indicating an end of the optical disk is formed. Next, a no-data area 46 in which no data is recorded is formed to allow a user to hold the optical disk.

[28] In embodiments of the present invention, read power information may be recorded in the lead-in area 43 located at an innermost circumference or the lead-out area 45 located at an outermost circumference in the data area on the optical disk. The read power information may be stored in either of the lead-in area 43 and the lead-out area 45 or may be stored in both of them for reliability. Here, it is preferable to record the read power information on a substrate of the optical disk in a form of pits or in a form of groove-wobbles to prevent the read power information from being changed. It is most preferable to record the read power information in a control data zone within the lead-in area 43 that will be described below.

[29] FIG. 4 illustrates a conventional data structure in a lead-in area on a disk. The lead-in area largely includes a pre-recorded zone, in which data is recorded during manufacturing and is not changed thereafter, and a re-writable zone, which changes when a user records data on the disk. The control data zone corresponds to the pre-recorded zone and stores information regarding the disk (hereinafter, referred to as a disk information) and information for copy prevention (hereinafter, referred to as a copy-prevention information). In addition, the control data zone includes a plurality of data fields storing various types of information including a disk type. Among those data fields, there are reserved fields in which no information is recorded during manufacturing of the disk so that information can be additionally recorded therein according to a manufacturer's necessity thereafter. In embodiments of the present invention, the read power information is recorded in an arbitrary one among the reserved fields such that read power information for a read-only area is recorded in a particular reserved field and read power information for a writable area is recorded in another particular reserved field. For example, referring to FIG. 4, the read power information for the read-only area is recorded in byte number 5 of the control data zone and the read power information of the writable area is recorded in byte number 6.

[30] Here, if the read power information is recorded according to predetermined rules, it will be more convenient and reliable. For example, read power information for a particular area may be recorded in a 1-byte field using the following method. As shown in FIG. 5, among eight bits, four most significant bits (MSBs) may be used to express an integer part of the read power information and four least significant bits (LSBs) may be used to express a fraction part of the read power information. For example, when an optimal read power is 1.5 mW, the 4 MSBs may be expressed by '0001' and the 4 LSBs may be expressed by '0101'. Then, an optical disk drive reads the 8 bits and can detect 1.5 mW. However, the above-described method of recording the read power information is just an example, and other various recording methods may be used in the present invention.

[31] The above-described principle of the present invention can also be applied when there are two or more read-only areas or writable areas. In addition, although the description has been made mainly referring to a hybrid optical disk including a read-only area and a writable area, the principle of the present invention can be applied to any type of optical disk that includes a plurality of types of data areas, such as a super-resolution disk area and a normal disk area, requiring different optimal read powers.

[32] Hereinafter, a recording/reproducing system, e.g., an optical disk drive, recording/reproducing data on/from a super-resolution optical disk having read power information according to an embodiment of the present invention will be described with reference to FIG. 6.

[33] FIG. 6 is a schematic diagram of a recording/reproducing system which records/reproduces data on/from an information storage medium on which different read power information has been recorded according to an embodiment of the present invention. The recording/reproducing system includes a pickup unit 50, a recording/reproducing signal processing unit 60, and a control unit 70. In details, the pickup unit 50 includes a laser diode 51 emitting light, a collimating lens 52 collimating light emitted from the laser diode 51, a beam splitter 54 converting a path of incident light, and an objective lens 56 collecting the light passing through the beam splitter 54 onto an information storage medium D.

[34] The light reflected from the information storage medium D is reflected by the beam splitter 54 and is then incident onto a photodetector, e.g., 4-division photodetector 57. The photodetector 57 converts the incident light into an electrical signal. An operation circuit 58 outputs the electrical signal to a first channel Ch1 detecting a sum signal and to a second channel Ch2 detecting a signal in a push-pull mode.

[35] The recording/reproducing system having the above-described structure is designed such that the pickup unit 50 emits a recording beam with a power higher than a predetermined value (e.g., 10 mW) according to a control by the control unit 70 so that a

recording mark having a size less than a resolution (e.g., 100 nm) can be formed when the recording/reproducing system records data on the information storage medium D. Data is recorded on the information storage medium D by the recording beam.

[36] The following description concerns a procedure in which data is reproduced from a hybrid information storage medium having different read power information according to an embodiment of the present invention. When the hybrid information storage medium is inserted into the recording/reproducing system, the recording/reproducing system reads a lead-in area of the hybrid information storage medium to obtain information regarding the hybrid information storage medium itself and information regarding data recorded on the hybrid information storage medium. Here, in the above-described manner, optimal read power information for a read-only area and optimal read power information for a writable area can be obtained. If the optimal read power information is recorded in a lead-out area, the recording/reproducing system reads the lead-out area to obtain the optimal read power information.

[37] The obtained optimal read power information for each area may be stored in memory (not shown) included in the control unit 70. Thereafter, when the recording/reproducing system reproduces data from the read-only area, the control unit 70 controls an output of the laser diode 51 referring to the optimal read power information for the read-only area stored in the memory. Similarly, when the recording/reproducing system reproduces data from the writable area, the control unit 70 controls the output of the laser diode 51 referring to the optimal read power information for the writable area stored in the memory. As a result, the recording/reproducing system can optimally reproduce data from any area on the hybrid information storage medium.